

## REMARKS

Claims 1-32 are pending in the application.

Claims 33-47 have been added.

Claims 1-32 are rejected under 35 U.S.C. § 112, first paragraph, as allegedly containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claims 3, 4, 10, 11, 20, 21, and 27-28 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1, 2, 3, 5, 8, 9, 12-19, and 21 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Kawanishi et. al. (English translation of Japanese Patent JP-39528) taken with Price et. al. (US Patent 4,632,057).

Claims 3, 6, 7, 10, 11, 20, 22, and 23 are rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Kawanishi taken with Price, and further in view of Brors et. al. (US Patent 4,565,157).

### **35 U.S.C. § 112, first paragraph**

Claims 1-32 stand rejected under the first paragraph of 35 U.S.C. § 112 as failing to meet the written description requirement, specifically, for allegedly failing to define or specify, in a full, clear and concise manner, the numerical values of x in the formula  $WSi_x$ .

By its definition, a silicide is a compound formed when silicon reacts with a metal. As known in the art of semiconductor manufacture, the term "tungsten silicide" refers to any silicide consisting of silicon and tungsten. Likewise, the chemical formula  $WSi_x$  is used in the art to generally represent "tungsten silicide." Regardless of whether the tungsten silicide referenced is  $WSi_2$ , or some other variation thereof, the formula  $WSi_x$  and the term "tungsten silicide" are generic representations encompassing all possible forms of tungsten silicide. *See*, 1 S. Wolf and R.N. Tauber, Silicon Processing for the VLSI Era, 386-393 (1986).

Therefore, the subscript x in the chemical formula  $WSi_x$  is adequately disclosed and defined in

the specification because one having ordinary skill in the art of tungsten silicide deposition processes, or in semiconductor manufacture, would understand the chemical formula WSi<sub>x</sub> to represent any and all forms of tungsten silicide that can be produced.

The specification refers to both "tungsten silicide" and "tungsten silicide (WSi<sub>x</sub>)" in describing the prior art and the present invention. In and of itself, the term "tungsten silicide" by definition encompasses all forms of tungsten silicide, including those listed in the Official Action, thereby disclosing the final product of the invention in a manner that can be practiced by an individual having ordinary skill in the art. Likewise, the term "tungsten silicide (WSi<sub>x</sub>)" encompasses all of the forms of tungsten silicide, thereby disclosing, in a full, clear, and concise manner, to one having ordinary skill in the art, the final product of the invention. In addition, the specification indicates that generally tungsten silicide in the form of WSi<sub>2</sub> is used or formed in the art, thereby achieving the requirements of 35 U.S.C. § 112, first paragraph. *See, Specification, col. 1, lines 15-18.*

Claims 1-32 are allowable because the term "tungsten silicide (WSi<sub>x</sub>)" clearly and concisely defines the final product so that the invention can be practiced. The rejection of claims 1-32 under 35 U.S.C. § 112, first paragraph, for allegedly failing to provide a written description of the invention in a full, clear and concise manner by not defining or specifying the numerical values of x in the formula WSi<sub>x</sub>, should be withdrawn and claims 1-32 allowed and passed for issue.

### **35 U.S.C. § 112, second paragraph**

Claims 3-4, 10-11, 20-21, and 27-28 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly indefinite because it is unclear as to which CVD process is referred to by the term "the (CVD) process" recited therein.

Claims 3-4, 10, 20-21, and 27 have been amended to include reference to "each of the (CVD) processes" of the claim from which they respectively depend, thereby placing claims 3-4, 10, 20-21, and 27 in condition for allowance.

Claims 11 and 28 depend from claims 10 and 27 respectively. Claim 11 does not recite the term "the (CVD) process" and is therefore allowable in light of the amendment to claim

10. Likewise, claim 28 does not recite the term "the (CVD) process" and is allowable in light of the amendment to claim 27.

**35 U.S.C. § 103(a) - obviousness in view of Kawanishi and Price**

Claims 1, 2, 4, 5, 8, 9, 12-19, and 21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi taken with Price.

As the Examiner indicates, Kawanishi teaches a process for depositing a tungsten silicide film on a substrate which comprises the steps of forming a low-temperature film of tungsten silicide on the substrate using a CVD process with a silane ( $\text{SiH}_4$ ) silicon source gas and a reactant gas of tungsten hexafluoride ( $\text{WF}_6$ ) at a temperature of  $360^\circ\text{C}$ , followed by the formation of a high-temperature film of tungsten silicide over the low-temperature film by a CVD process using a dichlorosilane ( $\text{SiH}_2\text{Cl}_2$ ) silicon source gas and tungsten hexafluoride ( $\text{WF}_6$ ) reactant gas at a temperature of  $680^\circ\text{C}$ . *See*, Kawanishi, English translation, page 6. Kawanishi expressly teaches the dual temperature deposition of tungsten silicide films with the second deposition at a high temperature (e.g.  $680^\circ\text{C}$ ) because tungsten silicide films formed at low temperatures (e.g.  $360^\circ\text{C}$ ) have "poor adhesion with the substrate and a poor step coverage," and are therefore undesirable. *See*, Kawanishi, English translation, page 4, paragraph 3.

Price differs from Kawanishi in that Price teaches that tungsten silicide deposition may occur in CVD processes using a dichlorosilane ( $\text{SiH}_2\text{Cl}_2$ ) silicon source gas at a temperature in the range of  $390^\circ\text{C}$  to  $400^\circ\text{C}$  without a second, high-temperature deposition step. However, Price expressly indicates that "plasma discharge appears necessary to initiate/nucleate deposition" in a low-temperature tungsten silicide deposition process. *See*, Price, col. 5, lines 60-63. Price thereby teaches that low-temperature deposition of tungsten silicide will only occur where a plasma ignition step is used to initiate the deposition process. Moreover, Price teaches a single step deposition process using a dichlorosilane source gas

Claims 1 and 8 of the present invention recite processes for depositing tungsten silicides occurring at a temperature of less than about  $500^\circ\text{C}$ . Likewise, claim 18 of the present invention recites a process for depositing a tungsten silicide nucleation layer and a tungsten

silicide film at a substantially equivalent temperature. In order to render the present invention obvious, Kawanishi, taken with Price, must motivate a successful process for depositing tungsten silicides performed at a temperature of less than about 500°C as in claims 1 and 8, or wherein a nucleation layer of tungsten silicide and a film of tungsten silicide are sequentially deposited at a substantially equivalent temperature as in claim 18.

A proper rejection of claims under 35 U.S.C. § 103 requires that the examiner establish an unrebutted *prima facie* case of obviousness. *See, In re Deuel*, 51 F.3d 1552, 1557, 34 USPQ2d 1210, 1214 (Fed. Cir. 1995). The MPEP defines the three basic requirements for a *prima facie* case of obviousness:

- (1) there must be a suggestion or motivation to modify or combine the reference teachings;
- (2) there must be a reasonable expectation of success; and
- (3) the prior art references must teach or suggest all of the claim limitations.

See, MPEP Section 2143. Thus, in order for the rejection of claims 1, 2, 4, 5, 8, 9, 12-19, and 21 for obviousness under 35 U.S.C. § 103(a) to stand, there must be a suggestion or motivation to combine Kawanishi and Price, there must be a reasonable expectation that the combination would be successful, and each of the claim limitations of the present invention must be taught by the prior art references.

There is no suggestion or motivation to combine Kawanishi with Price to achieve the present invention. Kawanishi expressly teaches that it is undesirable to perform tungsten silicide depositions at a constant low temperature because of poor adhesion and poor step coverage achieved using single temperature processes. *See*, Kawanishi, English translation, page 4, paragraph 3. Price teaches that single temperature tungsten silicide depositions require plasma ignition to initiate deposition of tungsten silicide. Although Price teaches that temperature control may not be critical to the deposition rate, Price indicates that the deposition will not begin without plasma ignition. *See*, Price, col. 5, lines 60-63. A combination of Kawanishi and Price would thus necessarily require the use of plasma ignition to initiate deposition in a single temperature process. Moreover, such a process is disfavored by Kawanishi, as noted above, so there is no motivation to combine the techniques of the two references. Such a technique fails to correspond to the present invention because the

combination fails to suggest or motivate a deposition process carried out at a temperature of less than about 500°C, or at a single temperature, without the aid of plasma ignition. Thus, the first requirement of a *prima facie* case of obviousness is not met.

The attempted combination of Kawanishi and Price also fails to meet the second requirement for a *prima facie* case of obviousness - the expectation of success. The processes recited in claims 1, 8, and 18 of the present invention are accomplished without a plasma ignition step. Price teaches that a plasma ignition step is necessary to achieve a single temperature deposition of tungsten silicide. Without such step, there can be no expectation of success. Therefore, Price's express teaching that the plasma ignition step is necessary precludes any reasonable expectation of success absent the plasma ignition limitation because Kawanishi teaches that deposition at a single temperature will not achieve the desired results and Price requires plasma ignition to perform deposition at a single temperature.

The combination of Kawanishi and Price also fails to teach or suggest all of the claim limitations of the present invention. The present invention performs a two-step tungsten silicide deposition process at a temperature less than about 500°C, or at substantially equivalent temperatures, without the use of plasma ignition. *See*, Specification, col. 4, lines 16-18. The process includes first the deposition of a tungsten silicide nucleation layer followed by the deposition of a tungsten silicide film. Kawanishi teaches that such a two step process may not be performed without a high temperature (e.g. 680°C) tungsten silicide deposition step, contrary to the present invention. Likewise, Price only teaches a single step tungsten silicide deposition process using plasma ignition. Neither Kawanishi nor Price teach or suggest that the deposition of tungsten silicide may occur at a temperature below 500°C, or at substantially the same temperature, without the use of plasma ignition.

A combination of Kawanishi with Price does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103(a) because there is no motivation to combine the teachings of the two patents, and any combination would expressly fail without the presence of a plasma ignition step, which is absent in the present invention. Therefore, claims 1, 8, and 18, are nonobvious and allowable. Likewise, claims 2, 4, 5, 9, 12-17, 19, and 21 which depend from claims 1, 8, and 18 are nonobvious because "dependent claims are nonobvious under section

103 if the independent claims from which they depend are nonobvious." *In re Fine*, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988). *See also*, MPEP § 2143.03. Therefore, the nonobvious nature of claims 1, 8, and 18 carries over to the aforementioned claims, and claims 1, 2, 4, 5, 8, 9, 12-19, and 21 are allowable.

Claim 14 also stands rejected under 35 U.S.C. § 103(a) as being obvious to one of ordinary skill in the art because the Examiner takes official notice that Argon, Nitrogen, or Helium are known individually as carrier gases and therefore a mixture thereof functions as a carrier gas in an additive or cumulative manner. In order to establish obviousness of claim 14, the Examiner must "identify specifically the principle, known to one of ordinary skill, that suggest the claimed combination." *In re Rouffet*, 97-1492 (Fed. Cir. 1998) (citing *Gechter v. Davidson*, 116 F.3d 1454, 43 USPQ2d 1030 (Fed. Cir. 1997)). The absence of a specific principle teaching that the mixture as recited in claim 14 will act as a carrier gas precludes a 35 U.S.C. § 103(a) rejection of claim 14.

Claims 13 and 15 also stand rejected under 35 U.S.C. § 103(a) because "discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art." *In re Boesch*, 617 F.2d 272, 205 U.S.P.Q. 215 (CCPA 1980)(emphasis added). The deposition time and flow rates recited in claims 13 and 15 are specific to the nonobvious process which is the subject of the present invention. As such, the deposition time and flow rates of claims 13 and 15 are effective variables of the process which was heretofore unknown by those skilled in the art. Therefore, the deposition time and flow rates are nonobvious because they pertain to a new process which was previously not known by those skilled in the art of deposition processes. Claims 13 and 15 are allowable.

Claims 16 and 17 are also rejected under 35 U.S.C. § 103(a) based upon the combination of Kawanishi and Price, in that the 360°C temperature of Kawaishi is considered substantially the same as the 390°C temperature of Price. However, the combination of Kawaishi with Price fails to establish a *prima facie* case of obviousness. Thus, even if a 360°C temperature is considered substantially equivalent to 390°C, which Applicant does not admit, a *prima facie* case of obviousness does not exist and claims 16 and 17 are allowable.

**35 U.S.C. § 1-3(a) - obviousness in view of Kawanishi, Price and Brors**

Claims 3, 6, 7, 10, 11, 20, 22, and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawanishi taken with Price and further in view of Brors et. al. (U.S. Patent 4,565,157).

Kawanishi and Price fail to establish a *prima facie* case of obviousness of the independent claims from which claims 3, 6, 7, 10, 11, 20, 22, and 23 depend. *See supra*. "Dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious." *In re Fine*, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988). *See also*, MPEP § 2143.03. Therefore, the nonobvious nature of the independent claims from which claims 3, 6, 7, 10, 11, 20, 22, and 23 depend carries over to the aforementioned claims. Claims 3, 6, 7, 10, 11, 20, 22, and 23 are therefore allowable.

In addition, the combination of Brors with Kawanishi and Price fails to establish a *prima facie* case of obviousness of claims 3, 6, 7, 10, 11, 20, 22, and 23. There is no motivation to combine the cold wall CVD reactor of Brors with Kawanishi or Price to achieve deposition of tungsten silicide as taught in the present invention. Likewise, the combined teachings of Brors, Kawanishi and Price would necessitate a plasma ignition step to achieve the deposition of tungsten silicide, which is not present in the current invention. The lack of motivation to combine Brors with Kawanishi and Price, and the expectation of failure without a plasma ignition step as in Price, precludes a *prima facie* case of obviousness. Therefore, claims 3, 6, 7, 10, 11, 20, 22, and 23 are nonobvious and allowable over the combination of Brors with Kawanishi and Price.

In addition, claims 7 and 23 are patentable over the combination of art as applied because the flow rates recited in those claims are not flow rates of a known process, but are rather flow rates in a process which was heretofore unknown. Thus, the rule of *In re Boesch* does not apply and claims 7 and 23 are allowable. *See supra*.

## Conclusion

Applicant respectfully requests entry of the amendments of this application. In addition, Applicant requests that claims 33-47 be entered.

Claims 1-32 are allowable over the Examiner's rejections for the aforementioned reasons. Claims 33-47 are also allowable. Applicant respectfully requests that the Examiner allow claims 1-47 and pass the case for issue.

Respectfully submitted,



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